

Claims:

1. A method for processing a workpiece, comprising the steps of:
providing a heated liquid onto the surface of the workpiece that is to be treated,
the heated liquid assisting in maintaining the workpiece at an elevated temperature;
5 introducing ozone into an environment containing the workpiece at a rate of at
least 90 grams per hour;
controlling the thickness of the heated liquid on the workpiece so as to form a
liquid layer that allows for diffusion of the ozone through the layer for reaction at the
surface of the workpiece.

2. A method for cleaning the surface of a workpiece, comprising the steps of:
providing a heated liquid solution of water and at least one of HF and HCl onto
the surface of the workpiece, with the heated solution assisting in maintaining the
workpiece at an elevated temperature;
15 introducing ozone into an environment containing the workpiece at a rate of at
least 90 grams per hour;
controlling the thickness of the heated liquid solution to form a thin liquid
boundary layer on the surface of the workpiece to allow diffusion of the ozone through
the boundary layer for reaction at the surface of the workpiece.

3. The method of claim 1 where the ozone is introduced at a rate of at least 130
grams per hour.

4. The method of claim 1 where the ozone is introduced at a flow rate of at least 10 lpm and a concentration of at least 10% by weight.

5. The method of claim 1 wherein the liquid comprises deionized water.

6. The method of claim 5 wherein the deionized water is superheated.

7. The method of claim 1 wherein the liquid includes sulfuric acid, hydrochloric acid, ammonium hydroxide, or deionized water.

8. The method of claim 1 wherein the step of controlling comprises the step of rotating the workpiece.

9. The method of claim 1 wherein the step of controlling comprises the step of rotating the workpiece at a rotation rate equal to or greater than about 300 rpm.

10. The method of claim 1 wherein the step of controlling comprises adding a surfactant to the liquid.

11. The method of claim 1 wherein the step of controlling comprises the step of spraying the liquid onto the surface of the workpiece at a controlled flow rate.

12. The method of claim 1 wherein the liquid includes water and HF at a concentration ratio of between about 50: 1 and 500: 1.

5/ 13. The method of claim 1 wherein the liquid includes water and HCl at a concentration ratio of between about 50: 1 and 500: 1.

14. The method of claim 1 wherein the liquid includes water, HF and HCl at a concentration ratio of between about 50: 1: 1 and 500: 1: 1.

10 15. A system for processing a workpiece, comprising:
a liquid reservoir having a liquid chamber;
one or more nozzles in a process chamber for spraying fluid onto the workpiece;
a fluid path connecting the liquid chamber to the nozzles;
an ozone supply system for injecting ozone into the fluid path or into the
15 chamber, and having a capacity of at least 90 gpm; and
a heater for heating the liquid before the liquid is provided onto the workpiece.

20 16. The system of claim 15 further comprising a mixer in the fluid path.

17. The system of claim 15 with the ozone supply system comprising a contactor for receiving the ozone and the liquid.

18. The system of claim 15 further comprising a re-circulation fluid path extending between the chamber and the liquid reservoir.

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5 19. The system of claim 15 further comprising a rotor assembly in the chamber for rotating the workpiece.

20. The system of claim 15 where the ozone supply system generates a flow of ozone at a flow rate of at least 10 lpm and a concentration of at least 10% by weight.

10 21. The system of claim 15 where the heater comprises a steam boiler.

22. The system of claim 15 with the heater disposed in the reservoir.

15 23. The system of claim 15 further comprising means for controlling the thickness of the liquid layer on the workpiece, including at least one of:

a rotor for rotating the workpiece;

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a fluid flow controller; or one or more nozzles adapted to generate fine droplets of the treatment liquid.

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24. The system of claim 15 where the nozzles have spray openings for spraying out liquid.

25. A method for processing a workpiece, comprising the steps of:
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introducing a liquid including HF onto the surface of the workpiece;
diffusing ozone through the liquid;
controlling the thickness of the liquid on the surface of the workpiece, to maintain a desired level of etch uniformity.

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